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Soft spin waves and magnetic instability in Skyrmion systems[1]

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In this work the highly correlated ground states of spin in 2D electron layers (2DES) near filling factor ν=1 are probed by inelastic light scattering [1]. In this filling factor range the ground state of the 2DES is affected by the proliferation of spin-charge textures known as Skyrmions. Recent experiments [2] have suggested the possibility of observing a long range Skyrme crystal phase with non-collinear magnetic order at low temperatures. The magnetic properties of the 2DES close to ν=1 are studied by the direct measurement of the low-lying spin wave excitations by inelastic light scattering between 2.5K and 40mK. We discovered a very low energy spin wave that emerges on both sides of ν=1. The spin wave is well below the Zeeman energy and exhibit surprising soft behavior with temperature changes: its energy increases with temperature and reaches the Zeeman energy for temperatures above 2K. These results suggest an instability of the 2DES towards magnetic order at low temperatures and filling factors close to ν=1. The spin excitation spectra are consistent with the ordering of the in-plane components of spin in a square Skyrme crystal phase proposed in theoretical evaluations [3], but never fully confirmed by experiments. Our experiments create venues for the determination of Skyrme crystal phases from measurements of low-lying spin excitations by inelastic light scattering.

[1] Y. Gallais et al, arXiv:0709.3240
[2] G. Gervais et al., Phys.Rev.Lett. 94, 196803 (2005)
[3] L. Brey et al., Phys.Rev.Lett. 75, 2562 (1995)

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